Rapid surveys for inventorying alien plants in the Black Sea region of Turkey

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The presence, distribution or abundance of many invasive alien plants is positively correlated with roads, so roads need to be taken into consideration when planning a survey in a poorly studied area. During the two field surveys organized in the framework of the 2nd Workshop on Invasive Plants in the Mediterranean Type Regions of the World,[1] 81 alien species were observed in the investigated area, i.e. 70 neophytes and 11 archeophytes (including 9 doubtful species), with 54 new records for the DAISIE inventory. Three of these species, *Acalypha australis, Microstegium vimineum* and *Polygonum perfoliatum*, were recorded near a tea factory, and the import of material for tea processing is expected to have been their pathway of introduction. The results of this survey in the region of Trabzon in North-East Turkey show that roadside surveys are a useful tool for early detection efforts, in compiling and updating national or regional inventories (especially with time and budget constraints). This survey, being organized in the framework of an international workshop, enabled knowledge to be shared between experts in the field, and training of students and researchers. These survey methods could be adapted, improved, and used elsewhere by others seeking to use early detection as part of their overall weed strategy or to gather baseline data on invasive alien plants in a poorly studied area.

Introduction

Biological invasions cause habitat degradation and loss of biodiversity at the global scale, and many countries are implementing national strategies and action plans. One of the key actions of most of the national (and regional) strategies is the compilation of a national/regional inventory of alien species. Many institutions intend to make inventories or to aggregate data on invasive alien species. The European and Mediterranean Plant Protection Organization (EPPO) maintains lists of known and emerging invasive alien plants, as well as a database of records; the European Environment Agency (EEA) has produced a list of the most invasive species (Streamlining European Biodiversity Indicators – SEBI – initiative); and the Bern Convention of the Council of Europe has aggregated existing official lists of invasive species (Genovesi *et al.*, 2010).

The DAISIE (Delivering Alien Invasive Species Inventories for Europe) project (2004–08), funded by the 6th Framework Programme of the European Union, had the objective of 'creating an inventory of invasive species that threaten European terrestrial, freshwater and marine environments'. The plant section of the DAISIE database is based on national checklists from 48 European countries, including some regions or islands, and Israel. For many of the national checklists the data were compiled during the project, and for some countries, DAISIE collected the first comprehensive checklists of alien species, based on primary data (e.g. Cyprus, Greece, Macedonia, Slovenia, Ukraine) (Lambdon *et al.*, 2008). Nevertheless, the DAISIE project reported only 220 taxa for Turkey, which should be considered an underestimation of the real situation.

Such data compilation has to be based on field work and needs to be constantly updated with dedicated surveys. These are also of fundamental importance in the establishment of a national system of early detection and rapid response. Many bibliographical sources exist to publish information on the discovery of new alien species in a country (e.g. *Le Monde des Plantes* in France; *Doga, Turkish Journal of Botany* for Turkey, etc.), although such information is not always easily accessible and sometimes, for different reasons, it may be released with some delay. Many botanists, when collecting specimens for herbaria, do not pay much attention to sampling the alien flora. To increase field knowledge on the alien flora, the field trip of the 2nd Workshop on Invasive Alien plants in Mediterranean Type Regions of the World was dedicated to creating inventories to be published as a pilot study.

[1]The 2nd Workshop on Invasive Plants in the Mediterranean Type Regions of the World was held at Trabzon from 2–6 August 2010. It was organized by the European Environment Agency, the Council of Europe, the European and Mediterranean Plant Protection Organization, the University of Igdir and The Turkish Ministry of Agriculture.

The presence, distribution or abundance of many invasive alien plants is positively correlated with roads (e.g. Trombulak & Frissell, 2000). Roads, railways and canals represent potential corridors along which alien species may spread as a direct result of the transit of goods and vehicles, as well as indirectly through local modification of the neighbouring environment by these infrastructures that can facilitate species establishment (Hulme *et al.*, 2008; Hulme, 2009). Tracks, houses and road networks have often been considered as preferential diffusion and dispersal corridors in the landscape for many invasive alien plant species, and also are conveniently used for monitoring invasions (e.g. Arteaga *et al.*, 2008). The road network between different countries facilitates the transport of alien plant species, raising the chance of new introductions of plant species and increasing the propagule pressure of already introduced plants at the global scale (e.g. Gelbard & Belnap, 2003; Fuentes *et al.*, 2010). Disturbance regimes in roadsides (road construction, maintenance activities, flooding) may produce habitat more prone to the establishment of alien species, and remove some biological barriers such as competitors and native plant species (Parendes & Jones, 2000). From this point of view, roads also need to be taken into careful consideration when planning a survey in a poorly studied area to develop an alien plant inventory, and when establishing a network of control points for a system of early warning.

In the case of the Trabzon region, areas surrounding tea factories are potential recipient habitats for new invasive species coming from countries that are the sources of commodities necessary for tea processing, or with which trade is particularly intensive, as for instance with Russia. Tea is grown in 36 tropical and semitropical countries, and the six largest producing countries are China, India, Kenya, Sri Lanka, Indonesia and Turkey (in that order), accounting for around 80% of world output. India consumes the equivalent of 80% of its annual production, while Turkey, the sixth largest producer, actually consumes more than it produces (CTA, 2010). Tea cultivation in Turkey is carried out predominantly in the eastern Black Sea region, from the Araklý district of Trabzon to the Georgian boundary, over more than 76 000 ha (Alkan *et al.*, 2009).

The indigenous vascular flora of the north-east of Anatolia has been subjected to dramatic alteration because of the invasion of alien species from various parts of the world, but especially as a consequence of introductions from east to west, so that new alien taxa have been continuously reported from the region, as emphasized by Terzioğlu & Karaer (2009).

Early detection of new invasive alien plant species allows for early control. This improves the chances of successful eradication and minimizes the impact of such species on the environment and on agriculture. All cases of successful control of invasive plant species were initiated during the early stages of invasion (Macdonald *et al.*, 1989). It seems that usually there is no chance of successful eradication once a species becomes established and begins to spread (e.g. Mooney & Drake, 1989; Genovesi *et al.*, 2010). Since 2008, the European Commission has formally recognized the urgent need to tackle invasions in its Communication *Towards an EU Strategy on Invasive Species* [COM (2008) 789 final], committing to develop a policy on the issue and to establish an early warning system.

This paper presents results of the workshop field excursion that was part of the 2nd Workshop on Invasive Plants in the Mediterranean Type Regions of the World, and the advantages and disadvantages of the methodology are discussed.

Materials and methods

Study area

The study area is located in the north-eastern part of the Black Sea region of Turkey (Fig. 1, Table 1). The morphology is roughly mountainous, ranging from 0 to 3500 m above sea level (asl). Volcanic and plutonic rocks dominate the geological

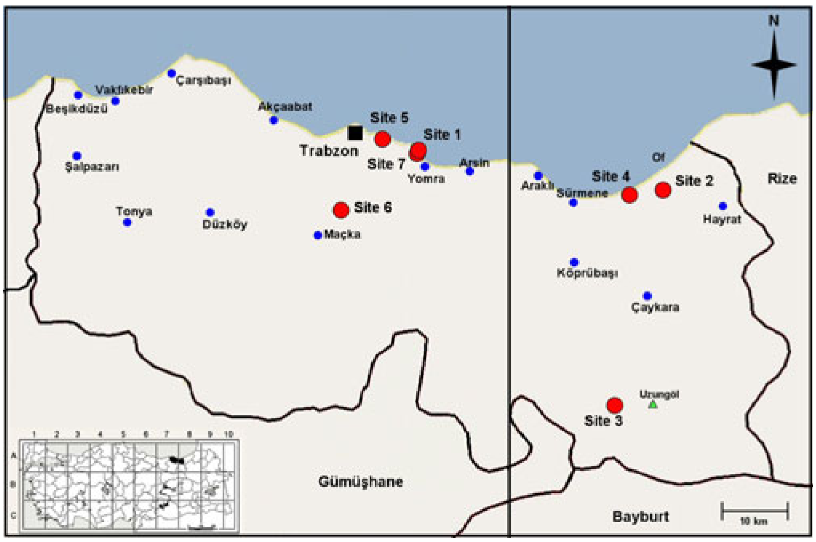

Fig. 1 Map showing the distribution of investigated sites during the field survey in the Trabzon area (sites are described in Table 1).

Table 1 Summary of the eight sites surveyed in North-East Turkey; habitats and land uses are indicated according to the EUNIS classification system

Site	Latitude	Longitude	Altitude (m asl)	Habitat/land use (EUNIS)
1 Novotel, at the coast line	40°58.047′	39°50.311′	0–10	(B & J) Sandy shores and ruderal
2 Tea factory (roadside)	40°55.678′	40°16.773′	50	(J, J4.2 & I) Ruderal and Nut Tree Farming
3 Lake Uzungol	40°37.067′	40°18.364′	1050–1100	(G & J) Forest, wetland and ruderal
4 Camburnu (*Pinus sylvestris* stand)	40°55.473′	40°12.750′	9	(G3) Coniferous forest
5 Arboretum of Karadeniz Technical University (KTU)	40°59.714′	39°46.507′	50–100	(I2.2) Arboretum – botanical garden
6 *Robinia pseudoacacia* stand (roadside) at Esiroglu town	40°52.890′	39°41.230′	222	(G1.C & J4.2) Plantation and ruderal
7 Trabzon town and roadside	40°57.871′	39°50.222′	10–20	(J, J4.2) Ruderal
8 Maçka town and roadside	40°49.116′	39°36.816′	400	(J, J4.2) Ruderal

structures of the region. A majority of the soils are podsolic, with low nutrient levels resulting from washing under high precipitation. The climate of the study area is similar to the Black Sea climate type of the region (Erinc, 1969); the winter is mild and rainy, the summer is moderately hot. The Değirmendere river basin has a short period of water deficit in the summer season. In the study area, three major vegetation types dominate: pseudomaquis, forest, and alpine communities (Davis *et al.*, 1965–85; Anşin, 1979; Acar *et al.*, 2004). The main, and more up-to-date, information available on the alien flora of Turkey comes from the DAISIE project database, accounting for 220 taxa [95 naturalized species, 115 casuals, 10 unspecified (i.e. status not assessed) and 3 cryptogenic species]. This data source, available online (http://www.europe-aliens.org/regionFactsheet.do?regionId=TUR;M00) was accessed in March 2011. It takes into account primarily Davis (1965–2002), thus it is not yet updated with many records occurring after 2002 that have been published in the *Turkish Journal of Botany*. The DAISIE project also reports the distribution of a set of 131 Turkish alien plant species according to the EUNIS habitat classification (10 species in coastal habitats; 9 in inland surface waters; 5 in grassland; 5 in heathland and scrubland; 9 in woodland and forest; 21 in inland sparsely vegetated habitats; 34 in arable land, gardens and parks; 38 in industrial habitats). Considering the size of the country, the diversity of habitats, the potential pathways of entry, and in comparison with neighbouring countries, the total number of 220 taxa of alien flora listed is expected to be much lower than the actual number present in Turkey.

Data collection

Botanical surveys should be conducted in the field at the appropriate times of year, when alien species' presence and invasive status are both evident and identifiable. The authors took the opportunity of having different experts on alien plants from different Mediterranean-type regions of the world to conduct a survey along roads and near urban or urbanized sites, to collect presence records (by GPS position) and herbarium samples to be stored at the Duzce University Forestry Faculty Herbarium (DUOF) for species including *Acalypha australis* L., *Amaranthus hybridus* L., *Digitaria sanguinalis* (L.) Scop., *Microstegium vimineum* (Trin.) A. Camus, *Oxalis corniculata* L., *Phyla nodiflora* (L.) Grene., *Polygonum perfoliatum* L., *Sicyos argulatus* L. and *Phytolacca americana* L. Species were identified when possible in the field, or later, and were photographed. Habitat data were recorded according to the EUNIS system (Davies & Moss 2003, available at http://eunis.eea.europa.eu/habitats.jsp), which provides a physical categorization of all major European habitat types. The authors applied to the EUNIS full list the simplified classification proposed by Lambdon *et al.*, 2008, which considers 10 main habitat types, as follows: A marine habitats; B coastal habitats; C inland surface waters; D mires, bogs and fens; E grasslands (and lands dominated by forbs, mosses or lichens); F heathland, scrub and tundra; G woodland, forest (and other wooded land); H inland unvegetated or sparsely vegetated habitats; I arable land, gardens and parks (regularly or recently cultivated agricultural, horticultural and domestic habitats); and J constructed, industrial and other artificial habitats (the code J4.2 indicates road networks).

The nomenclature used follows *Flora of Turkey and the East Aegean Islands* Vols 1–9 (Davis *et al.*, 1965–85; *Flora of Turkey and the East Aegean Islands* Vol. 10 (Davis *et al.*, 1988), and *Flora of Turkey and the East Aegean Islands* Vol. 11 (Güner *et al.*, 2000).

Invasive status of observed species

The status of the alien species encountered during the survey was recorded as casual, naturalized or alien, according to the definitions used by Brunel *et al.* (2010), which integrate assessments of spread potential and impacts, on the basis of field observations and expert knowledge within the group of surveyors. In addition 'only planted' taxa were recorded when they were found very commonly along roads. These are usually ornamental or 'soil-stabilizing' species known to be invasive in other regions of the word, and are planted in large quantities along roads, railways, urban areas, public and private gardens and riparian networks, and represent potential reservoirs for future invasion outbreaks.

Results and discussion

During the two field surveys, 81 alien species were observed in the area investigated (Fig. 1): 70 neophytes and 11 archeophytes

Table 2 The 81 alien species recorded during the 2010 survey

No	Family	Species	NR	LS	GF	RS	1	2	3	4	5	6	7	8	N
1	Malvaceae	*Abutilon theophrasti* Medik.	W. Asia	Annual	Herb	ARC	Nat	–	–	–	–	–	–	–	*
2	Fabaceae	*Acacia dealbata* Link.	Australia	Perennial	Tree	NEO	–	–	–	–	Cas	–	PL	–	
3	Euphorbiaceae	*Acalypha australis* L.	E. Asia	Annual	Herb	NEO	–	Nat	–	Nat	–	–	–	–	*
4	Aceraceae	*Acer pseudoplatanus* L.	W. Asia	Perennial	Tree	NEO	–	–	PL	–	–	–	PL	–	*
5	Agavaceae	*Agave americana* L.	C. America	Perennial	Tree-Like	NEO	–	–	–	–	Cas	–	PL	–	
6	Simarubaceae	*Ailanthus altissima* (Miller) Swingle	N. China	Perennial	Tree	NEO	Nat	–	Nat	–	–	–	Nat	–	
7	Fabaceae	*Albizzia julibrissin* Durazzo	Asia	Perennial	Tree	NEO	–	–	–	–	–	–	PL	–	*
8	Amaranthaceae	*Amaranthus chlorostachys* L.	N. America	Annual	Herb	NEO	–	–	–	–	–	Nat	–	Cas	*
9	Amaranthaceae	*Amaranthus graecizans* L.	Paleotrop	Annual	Herb	NEO	–	Nat	–	–	–	Nat	–	–	*
10	Amaranthaceae	*Amaranthus hybridus* L.	N. America	Annual	Herb	NEO	–	–	–	–	–	Nat	–	–	
11	Asteraceae	*Ambrosia artemisiifolia* L.	N. America	Annual	Herb	NEO	–	–	–	–	Nat	–	Nat	–	
12	Fabaceae	*Amorpha fruticosa* L.	N. America	Perennial	Shrub	NEO	–	–	–	–	–	–	Cas	–	
13	Asteraceae	*Artemisia annua* L.	W. Asia	Annual	Herb	NEO	Nat	–	–	–	–	Nat	Nat	–	*
14	Asteraceae	*Artemisia verlotiorum* Lamotte	E. Asia	Perennial	Herb	NEO	Nat	–	–	–	–	–	Nat	–	
15	Asteraceae	*Bidens frondosa* L.	N. America	Annual	Herb	NEO	–	–	–	–	–	–	–	Nat	*
16	Poaceae	*Bromus tectorum* L.	Doubtful	Annual	Herb	ARC?	–	–	–	–	Nat	–	–	–	*
17	Buddlejaceae	*Buddleja davidii* Franchet	China	Perennial	Shrub	NEO	–	–	Nat	–	–	–	INV	–	*
18	Cannaceae	*Canna indica* L.	S. America	Perennial	Herb	NEO	–	–	–	–	–	–	Cas	–	
19	Cupressaceae	*Chamaecyparis lawsoniana* (Murray) Parl.	N. America	Perennial	Tree	NEO	–	–	PL	–	–	–	PL	–	*
20	Euphorbiaceae	*Chamaesyce nutans* (Lag.) Small	N. America	Annual	Herb	NEO	–	Nat	–	–	–	–	–	–	*
21	Euphorbiaceae	*Chamaesyce prostrata* (Aiton) Small	N. America	Annual	Herb	NEO	Nat	–	–	Nat	Nat	–	–	–	*
22	Chenopodiaceae	*Chenopodium botrys* L.	Paleotrop	Annual	Herb	ARC?	–	–	–	–	–	Nat	–	–	*
23	Commelinaceae	*Commelina communis* L.	China	Annual	Herb	NEO	–	Cas	–	Nat	–	–	–	–	
24	Cyperaceae	*Cyperus esculentus* L.	Tropical	Perennial	Herb	ARC?	Nat	–	–	–	–	Nat	–	–	*
25	Solanaceae	*Datura stramonium* L.	America	Annual	Herb	NEO	Nat	–	–	–	–	Nat	Nat	–	*
26	Poaceae	*Digitaria sanguinalis* (L.) Scop	Cosmopol	Annual	Herb	NEO	Nat	Nat	–	Nat	Nat	–	Nat	–	*
27	Ebenaceae	*Diospyros lotus* L.	Asia	Perennial	Tree	NEO	–	–	–	–	–	Cas	–	–	
28	Poaceae	*Echinochloa erecta* (Pollacci) Pign.	E. Asia	Annual	Herb	NEO	Nat	Nat	–	–	–	–	–	–	*
29	Poaceae	*Eleusine indica* (L.) Gaertn.	Africa	Annual	Herb C4	NEO	Nat	–	–	Nat	Nat	–	–	–	*
30	Asteraceae	*Erigeron annuus* L.	N America	Annual	Herb	NEO	Nat	–	–	–	–	–	–	–	
31	Asteraceae	*Erigeron bonariensis* L.	C. America	Annual	Herb	NEO	–	Nat	–	–	–	–	–	–	
32	Asteraceae	*Erigeron canadensis* L.	N. America	Annual	Herb	NEO	Nat	–	Nat	Nat	Nat	–	Nat	Nat	
33	Asteraceae	*Erigeron sumatrensis* Retz.	S. America	Annual	Herb	NEO	Nat	–	–	–	–	–	–	–	*
34	Rosaceae	*Eryobotrya japonica* (Thunb.) Lindley	E. Asia	Perennial	Tree	NEO	–	–	–	–	–	–	PL	–	
35	Myrtaceae	*Eucalyptus camaldulensis* Dehn.	Australia	Perennial	Tree	NEO	–	–	–	–	–	–	PL	–	
36	Asteraceae	*Galinsoga ciliata* (Raf.) S.F.Blake	S. America	Annual	Herb	NEO	–	Nat	Nat	–	–	–	–	–	*
37	Asteraceae	*Helianthus annuus* L. s.l.	C./N. America	Annual	Herb	NEO	–	–	–	–	–	–	Cas	–	
38	Saxyfragaceae	*Hydrangea macrophylla* (Thunb.) Ser.	E. Asia	Annual	Herb	NEO	–	–	PL	–	–	–	PL	–	*
39	Sapindaceae	*Koelreuteria paniculata* Laxm.	China	Perennial	Tree	NEO	–	–	–	–	Cas	–	PL	–	*
40	Aizoaceae	*Lampranthus roseus* (Willd.) Schwantes	S. Africa	Perennial	Subshrub	NEO	PL	–	–	–	–	–	–	–	*
41	Verbenaceae	*Lantana camara* L.	C./S. America	Perennial	Shrub	NEO	–	PL	–	–	–	–	PL	–	*
42	Oleaceae	*Ligustrum japonicum* Thunb.	Asia	Perennial	Tree	NEO	–	–	–	PL	–	–	PL	–	*

Table 2 (Continued)

No	Family	Species	NR	LS	GF	RS	1	2	3	4	5	6	7	8	N
43	Caprifoliaceae	*Lonicera japonica* Thunb.	E. Asia	Perennial	Vine	NEO	–	PL	–	–	–	–	PL	–	*
44	Asteraceae	*Matricaria discoidea* DC	N./E. Asia	Annual	Herb	NEO	Nat	–	–	–	–	–	–	–	
45	Poaceae	*Microstegium vimineum* (Trin.) A.Camus	E. Asia	Annual	Herb	NEO	–	–	–	INV	–	–	–	–	
46	Meliaceae	*Melia azedarach* L.	Asia	Perennial	Tree	NEO	–	–	–	–	Cas	–	Cas	–	
47	Nyctaginaceae	*Mirabilis jalapa* L.	C./S. America	Annual(?)	Forb/Herb	NEO	–	–	Cas	–	–	Cas	Cas	–	*
48	Oxalidaceae	*Oxalis corniculata* L.	Cosmopol	Annual(?)	Herb	ARC?	–	Nat	–	Nat	–	–	–	Nat	*
49	Oxalidaceae	*Oxalis stricta* L.	S. America	Annual(?)	Herb	NEO	Nat	–	–	–	Nat	–	–	–	*
50	Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	N. America	Perennial	Vine	NEO	–	–	–	–	–	–	PL	–	*
51	Poaceae	*Paspalum dilatatum* Poiret	S. America	Annual/Perennial	Herb	NEO	Nat	Nat	–	Nat	Nat	Nat	Nat	–	
52	Scrophulariaceae	*Paulownia tomentosa* (Sprengel) Steud.	Asia	Perennial	Tree	NEO	–	–	Cas	–	–	–	–	–	*
53	Poaceae	*Pennisetum* sp.	Tropical	Annual/Perennial	Herb	NEO	PL	–	–	–	–	–	–	–	*
54	Arecaceae	*Phoenix canariensis* Chabaud	Canary Is.	Perennial	Tree	NEO	–	–	–	–	–	–	PL	–	
55	Verbenaceae	*Phyla nodiflora* (L.) Greene	S. America	Perennial	Forb/Herb	NEO	Nat	–	–	–	–	–	–	–	*
56	Poaceae	*Phyllostachys aurea* Carrière ex Rivière & C. Rivière	Asia	Perennial	Herb	NEO	PL	–	–	–	–	–	–	–	*
57	Phytolaccaceae	*Phytolacca americana* L.	N. America	Annual/Perennial	Herb	NEO	Nat	Nat		Nat	Nat	Nat	Nat	Nat	
58	Pinaceae	*Picea abies* (L.) Karsten	Eurosib.	Perennial	Tree	NEO	–	–	PL	–	–	–	–	–	*
59	Polygonaceae	*Polygonum perfoliatum* L.	Asia	Annual	Traling Vine	NEO	–	INV	–	–	–	–	–	–	*
60	Salicaceae	*Populus nigra* L. subsp. *italica* (Duroi) Asch. et Graeb.	Asia	Perennial	Tree	ARC?	–	–	–	–	–	–	PL	–	*
61	Salicaceae	*Populus x canadensis* Moench.	Hybrid	Perennial	Tree	NEO	Cas	–	–	–	–	–	Cas	–	*
62	Portulacaceae	*Portulaca oleracea* L.	Cosmopol	Annual	Herb	ARC	Nat	–	–	–	Nat	–	–	–	*
63	Pinaceae	*Pseudotsuga menziesii* (Mirb.) Franco	N. America	Perennial	Tree	NEO	–	–	PL	–	–	–	–	–	*
64	Euphorbiaceae	*Ricinus communis* L.	Africa	Annual/Perennial	Shrub	ARC?	–	Nat	–	–	–	–	Nat	–	
65	Fabaceae	*Robinia pseudoacacia* L.	N. America	Perennial	Tree	NEO	Nat	–	PL	Nat	–	Nat	Nat	Nat	
66	Fabaceae	*Robinia pseudoacacia* L. cv 'Purple Robe'	N. America	Perennial	Tree	NEO	PL	–	–	–	–	–	–	–	*
67	Poaceae	*Setaria faberi* F.Herm.	Cosmopol	Annual	Herb	NEO	–	Nat	–	Nat	–	–	–	–	*
68	Poaceae	*Setaria vericillata* (L.) Beauv.	Cosmopol	Annual	Herb	NEO	–	Nat	Nat	–	–	Nat	–	Nat	*
69	Poaceae	*Setaria viridis* (L.) Beauv.	Cosmopol	Annual	Herb	NEO	–	Nat	–	–	Nat	–	Nat	Nat	*
70	Cucurbitaceae	*Sicyos angulatus* L.	America	Perennial?	Vine	NEO	–	INV	–	–	–	Nat	–	–	*
71	Solanaceae	*Solanum luteum* Miller (=*S. villosum* Miller)	Euri-Medit	Annual	Herb	ARC?	–	Nat	–	Nat	–	Nat	Nat	Nat	*
72	Solanaceae	*Solanum lycopersicon* L.	C./S. America	Annual	Herb	NEO	–	Cas	–	–	–	Cas	–	–	*
73	Solanaceae	*Solanum nigrum* L.	Cosmopol	Annual	Herb	ARC?	Nat	Nat	–	Nat	–	Nat	–	–	*
74	Poaceae	*Sorghum halepense* (L.) Pers.	Cosmopol	Perennial	Herb	ARC?	Nat	–	–	–	Nat	Nat	Nat	–	*
75	Asteraceae	*Symphyotrichum squamatum* (Spreng.) G.L.Nesom	C./S. America	Annual	Herb	NEO	Nat	–	–	–	–	–	–	–	*
76	Asteraceae	*Tagetes minuta* L.	S. America	Annual	Herb	NEO	–	–	–	–	–	Cas	–	–	
77	Bignoniaceae	*Tecomaria capensis* (Thunb.) Spach	S. Africa	Perennial	Vine	NEO	–	–	–	–	–	–	PL	–	*
78	Arecaceae	*Trachycarpus fortunei* (Hook.) H.Wendl.	E. Asia	Perennial	Tree	NEO	–	–	–	–	–	–	PL	–	
79	Asteraceae	*Xanthium spinosum* L.	S. America	Annual	Herb	NEO	Nat	–	–	–	–	Nat	–	–	*
80	Asteraceae	*Xanthium strumarium* L.	Cosmopol	Annual	Herb	NEO	Nat	Nat	–	–	–	Nat	Nat	Nat	*
81	Poaceae	*Zea mays* L.	C./S. America	Annual	Herb	NEO	–	–	–	–	–	–	PL	–	

The columns in the table report the progressive number (No), the name of the alien species, the family, the geographical origin (NR), the life span (LS), the growth form (GF), the residence status (ARC, archeophytes; NEO, neophytes; ARC?, doubtful), the status in the 8 investigated sites (PL, only planted; Cas, Casual; Nat, naturalized; INV, invasive). The asterisk in the last column indicates that this is one of the 54 new records for the DAISIE database.

(including doubtful archeophytes). These 81 species are listed in Table 2, with their family, native range, life form, growth form, alien status, and occurrence in the 8 sites investigated. The total number is roughly one-third of the alien flora of Turkey according to the DAISIE database (although the 220 alien taxa in that database probably underestimates the total allodiversity). This paper reports 54 new records, i.e. species that are not present in the DAISIE database (although some of these may have been recorded in Turkey by other authors).

Between the 70 neophytes, 20 have been observed as only planted species, 13 as only casual, and 37 from naturalized to invasive (according to Brunel *et al.*, 2010).

The observed group of species is an interesting subset of the total alien flora, with species from deliberate and accidental introductions, well known invasive species and emerging ones. Some are described in the following sections as worthy of particular attention, and are presented in two subsets: widespread invasive species in the Black Sea region of Turkey; and emerging invasive species in the Black Sea region of Turkey. These two categories are hereafter used and defined according to the frequency of records during the survey and to the available literature on their distribution pattern and impacts, both actual or potential, considering, respectively, the investigated region and similar regions where they are already invasive.

Widespread invasive species in the Black Sea region of Turkey

Buddleja davidii Franch, native to China, is a large, deciduous shrub with arching branches that can reach a height of several metres and has fragrant, cone-shaped flower spikes. Dense stands of several square metres along the rivers Altindere and Cosandere in the Altindere valley were observed during the survey. *Buddleja davidii* is a problematic, noxious weed in several countries worldwide, and produces copious, viable seeds that are easily dispersed into both disturbed and natural areas. It is also a popular garden plant, valued for its brightly coloured, fragrant flowers, which attract butterflies, and its ease of cultivation.

Robinia pseudoacacia L. is a well known forestry species native to the Appalachian region of eastern North America, widely planted in Turkey mainly for the purposes of timber production and combating soil erosion, and appreciated by beekeepers (Terzioğlu *et al.*, 2007). Although the species is widely planted in Europe, its removal is carried out within several LIFE Nature projects (Scalera & Zaghi, 2004).

Sicyos angulatus L., native to North America, was deliberately introduced into many European countries either as an ornamental plant or as a contaminant of maize seeds from North America (Larché, 2004). It is particularly invasive in maize crops in the south-west of France. In Spain, early detection in 2002, followed by an official control program started in 2005, aimed to eradicate the plant. It has been recorded as naturalized in Turkey since the 1990s (Terzioglu & Ansin, 1999). In the Trabzon area, as observed during the survey, this species forms dense stands along roadsides, field edges (hazelnut trees) and forest edges.

Emerging invasive species in the Black Sea region of Turkey

In order to conduct effective management actions, the identification of emerging invasive alien species is of fundamental importance. The field trip identified six emerging invaders.

Acalypha australis L. (Euphorbiaceae) is an annual species originating from Western Asia, and was collected in north-east Anatolia for the first time in 2009 (Duman & Terzioğlu, 2009). Owing to the presence and distribution of *A. australis* in the Caucasus as a weed of all cultures except rice (Poyarkova, 1974; Kravchenko, undated), its distribution in the Turkish Caucasus is not surprising. It was found in two sites (Table 2) during the field survey: in the surroundings of the tea factory, which might be its first place of introduction; and in a *Pinus sylvestris* stand, which may be a habitat in which the species has escaped. According to DAISIE, the only record of this species being established in Europe is in Italy. Several other species of the genus *Acalypha* have been introduced in Europe and could become established as an alien weed of arable fields.

Amorpha fruticosa L. (Fabaceae) is a nitrogen-fixing shrub originating from North America. This species is already widespread in the western part of the Mediterranean Basin, especially in the south of France and in Italy, where it is considered invasive. The species is recorded on the EPPO List of Invasive Alien Plants. Its dense growth habit can easily lead to dense stands and reduce local species richness and/or change vegetation composition (in favour of nitrophilous species) on coastal dunes and along riparian habitats. *Amorpha fruticosa* is established in Turkey (DAISIE), but it has only been observed as casual in urban areas of Trabzon.

Lonicera japonica Thunb. *ex* Murray (Caprifoliaceae) is a woody vine which can reach 10 m in height. Introduced from eastern temperate Asia (China, Japan, Korea) as an ornamental plant, it has become invasive in many regions of the world (e.g. Australia, North America, Hawaii). In the western Mediterranean Basin, it is locally invasive in France and Italy. Not cited for Turkey in DAISIE, the survey recorded it only as planted (at the tea factory and in Trabzon city). *Lonicera japonica* invades riparian forests, forest openings and the edges of wetlands. This vine can smother small trees and shrubs, and can also cover large areas on forest floors, displacing native species. Seeds are easily dispersed over long distances by birds eating the fruits.

Microstegium vimineum (Trin.) A. Camus (Poaceae) was collected in Turkey at Giresun (north-east Anatolia) for the first time in 2000 (Scholz & Byfield, 2000). As far as the authors know, the population found at Surmene-Camburnu (Trabzon) in the north-eastern Black Sea Region, during the field excursion, is the second record for the country. Japanese stilt grass has been reported to be invasive in natural areas (e.g. banks of continental water, riverbanks/canalsides, forested wetlands) in the USA since 1972 (Fairbrothers & Gray, 1972), but was first discovered in Tennessee in 1919 and has since spread throughout most of the eastern United States. It is a pioneer species that spreads by rooting at stem nodes that touch the ground, and can produce very dense stands (400 rooted stems m^{-2}), especially in rich, floodplain soils (Barden, 1987). An individual plant may produce 100–1000 seeds that fall close to the parent plant. Seeds may be carried further by water currents during heavy rains, or moved in contaminated hay, soil or potted plants, and on footwear. Stilt grass seeds remain viable in the soil for 5 or more years and germinate readily (Cheplick, 2006). Controlling the spread of *M. vimineum* and restoring invaded areas are primary concerns of many land managers throughout the eastern United States (Czarapata, 2005; Flory, 2010). This species was added to the EPPO Alert list in 2008.

The annual herbaceous vine *Polygonum perfoliatum* L. (Polygonaceae), native to India and East Asia, belongs to the section Echinocaulon Meisner. It is known as a noxious environmental weed in North America (Kumar & DiTommaso, 2005). Its English name, mile-a-minute, illustrates its ability to grow very rapidly. Its presence in Turkey has been recorded since the beginning of the 1980s (Güner, 1984). The plant can smother shrubs and outgrow other vegetation, for example in tea plantations, where it also constitutes a significant hindrance to agricultural operations, blocking available light and reducing the ability of underlying crops to photosynthesize. In Turkey, the plant is present on the northern face of the Kaçkar range of mountains in North-Eastern Turkey, in Rize, district Ardeşen, near Firtina Deresi (Black Sea region), and has also been recorded during the workshop field survey at the tea factory (Table 2). Since the Turkish locations are the only ones recorded in the EPPO region, and given the potential impact of the species on agriculture, forestry and native vegetations, *P. perfoliatum* was added to the EPPO A2 List in 2008.

Phyla nodiflora (L.) Grene (or *Lippia nodiflora*) (Verbenaceae) is a widely invasive species worldwide. Due to a large subtropical distribution, its precise area of origin remains unclear, but it is considered native in the Mediterranean regions (Spain, Italy, Corsica, e.g. Jeanmonod & Gamisans, 2007). *Phyla nodiflora* has morphological characters closely resembling those of *Phyla canescens* (syn.: *P. filiformis*). There is therefore a need for more precise verification of herbarium samples of the two species stored in Turkish herbaria, to refine information on their presence and distribution. For example, the genus *Phyla* in Australia underwent a full taxonomic revision by the South Australian Herbarium after many years of attempted revision (Leigh & Walton, 2004). Following this revision (Munir, 1993), the two distinct species of the genus are now recognized as both occurring in Australia. They are now separated on the basis of their different environmental requirements in terms of climatic and soil type adaptations, as well as their morphology. Munir also notes that the plant exhibits a number of variable forms (differently sized leaves and other features) in the field. (Leigh & Walton, 2004).

In Australia, both *P. canescens* and *P. nodiflora* are categorized as 'W4cp noxious weeds' under the Noxious Weeds Act 1993. *Phyla nodiflora* it is a major weed of pastures, and could be increasingly problematic in zero-tillage cultivation and on irrigation structures. It produces only a relatively small bulk of feed, and has a major negative impact on pastures by replacing other species in what are often the most productive areas. It also has a major negative impact on waterways, as its extensive root system dries the soil to depth, leading to extensive soil cracking and leaving the soil open to erosion. This characteristic could easily lead to cracking and failure of storage and irrigation banks if this weed becomes established in such places (Leigh & Walton, 2004). In the Mediterranean Basin, *P. canescens* is already highly invasive in wet and salt land pastures in the south of France, where it covers thousands of square metres, reducing species richness and forage quality. In contrast, *P. nodiflora* is very localized in Corsica.

Three of these six emerging invasive species*, A. australis, M vimineum* and *P. perfoliatum*, were recorded in the surroundings of the tea factory, and the imports of material for tea processing and trade are considered to represent their most probable pathway of introduction.

Conclusions

The principle and concepts of early detection and rapid response to incipient plant invaders have been promoted internationally, nationally, and locally as a potentially cost-effective strategy in addressing plant invasions (Genovesi *et al.*, 2010).

Botanical surveys of roadsides and locations of imported plant material (such as tea factories) and other land uses, enable rapid surveys to be carried out. Roads may be paved streets, unpaved roads or trails, such as paths towards tourist or historical sites (e.g. Sumela monastery). Road networks are always described as invasion corridors; but they also provide repeatable transects through areas of human land use, and can be an efficient way to map species' distribution and monitor newly introduced plant species. Searching along roads can be effective because both urban centres and also isolated human habitations (which may be sites of secondary foci of newly invasive species, particularly ornamentals) occur along them, and vast distances can be covered with minimal effort (Kueffer & Loope, 2009). Roadside surveys can be also an aid in the production of distribution maps, and help in estimating the feasibility of eradication versus containment. Road surveys are, of course, a first-draft, preliminary estimation, and can be biased by the time of the year and other constraints, but they can profitably be considered as part of a more intensive strategy, and can be enhanced through a variety of other methods, including a more statistically sound stratified sampling methodology (e.g. Gelbard & Belnap, 2003; Barnett *et al.*, 2007), field interviews, literature searches, further surveys/searches at more detailed scale or on foot, or remote sensing data from aerial or satellite platforms.

The results of this survey in the north-east Turkish region of Trabzon show that roadside surveys are a useful tool in early detection efforts for compiling and updating national or regional inventories, especially where there are significant constraints such as time availability and a small inventory budget. This survey, which was organized in the framework of an international workshop, has also been a good opportunity to share knowledge between experts in the field and to train students and researchers. These survey methods could be adapted, enhanced and used elsewhere by others seeking to use early detection as part of their overall weed strategy, or who want to gather baseline data on invasive alien plants in a poorly studied area or region. It is remarkable that, in a few days, a significant percentage of the alien flora of Turkey was observed, including 54 new records for the DAISIE database and 6 emerging invasive aliens.

The authors believe that the results of this rapid botanical survey will serve as a basis for further study of the alien flora, contributing to the development of ways to restore natural (native) vegetation where necessary, and offering suggestions for long-term monitoring.

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Prospections rapides pour inventorier les plantes exotiques dans la région de la Mer Noire en Turquie

La présence, la répartition ou l'abondance de nombreuses plantes exotiques envahissantes sont corrélées positivement avec la présence de routes; des prospections botaniques dans une zone peu étudiée peuvent donc utilement prendre en compte les routes. Au cours de deux prospections de terrain organisées dans le cadre du 2^{e} Atelier sur les Plantes envahissantes dans les régions méditerranéennes du monde, 81 espèces exotiques ont été observées dans la zone investiguée, soit 70 néophytes et 11 archéophytes (dont 9 espèces incertaines), avec 54 nouveaux signalements pour l'inventaire DAISIE. Parmi ces espèces, 3 (*Acalypha australis, Microstegium vimineum* et *Polygonum perfoliatum*) ont été signalées près d'une fabrique de thé, et l'importation de matériel pour le traitement du thé aurait constitué la filière de leur introduction. Les résultats de cette prospection dans la région de Trabzon dans le nord-est de la Turquie montrent que les prospections de bords de route constituent un outil utile pour les efforts de détection précoce, et pour compiler et mettre à jour des inventaires nationaux ou régionaux (en particulier en cas de contraintes de temps et de budget). Cette prospection organisée dans le cadre d'un atelier de travail international a permis de partager des connaissances entre experts sur le terrain et de former étudiants et chercheurs. Ces méthodes de prospection pourraient être adaptées, améliorées, et utilisées ailleurs par d'autres personnes cherchant à utiliser la détection précoce comme un élément de stratégie contre les adventices ou pour assembler des données de base sur les plantes exotiques envahissantes dans une zone peu étudiée.

Оперативные обследования, позволяющие инвентаризировать чужеродные растения в районе Черного моря, в Турции

Наличие, распространение или обилие многих инвазивных чужеродных растений коррелировали с автодорогами, поэтому автодороги следует учитывать при планировании обследования плохо изученной зоны. Во время двух полевых обследований, организованных в рамках 2-го семинара по инвазивным растениям в районах мира средиземноморского типа, в исследовавшейся области наблюдался 81 чужеродный вид, то есть 70 неофитов и 11 археофитов (в т.ч. 9 сомнительных видов), с 54 новыми сообщениями для инвентарного перечня DAISIE. Три из этих видов, *Acalypha australis*, *Microstegium vimineum* и *Polygonum perfoliatum* были зарегистрированы возле чайной фабрики, поэтому предполагается, что импорт материалов для переработки чая явился путем их интродукции. Результаты этого обследования в области Трапезунда, в северо-восточной Турции, показывают, что придорожные обследования представляют собой весьма полезный инструмент для раннего обнаружения, компиляции и обновления национальных или региональных перечней, (особенно при ограниченности времени и бюджета). Это обследование, организованное в рамках международного семинара, позволило провести обмен знаниями между экспертами в области обучения студентов и исследователей. Подобные методы обследования могли бы быть адаптированы, усовершенствованы и использованы в других местах, чтобы применять раннее обнаружение в качестве элемента общей стратегии в отношении сорняков или сбора основных данных по инвазивным чужеродным растениям в плохо изученной зоне.

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